SOLUTION OF A PROBLEM.

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Problem.—What must be the size of an auger that will cut away just half of a solid ball 3 inches in diameter, by boring two holes, perpendicular to each other, through its center?

Solution.—Let $r=$ radius of ball and $x=$ radius of the auger. The volume of the ball is $\frac{4}{3}\pi r^3$. The part bored away will consist of the volumes of two cylinders, *ABDE* and *GKIH* *minus* the volume cut from one of the cylinders by the other *plus* the four segments at the ends of the two cylinders, which must $=\frac{1}{2}$ of $\frac{4}{3}\pi r^3=\frac{2}{3}\pi r^3$. The volume of each cylinder $=2\pi x^2\times\sqrt{(r^2-x^2)}$, $\therefore$ that of the two cylinders $=4\pi x^2\sqrt{(r^2-x^2)}$. The volume cut from one cylinder by the other is $\frac{2}{3}$ the cube of the diameter of its base $=\frac{2}{3}(2x)^3=\frac{16}{3}x^3$. The volume of each segment $=\frac{2}{3}\pi r^2[r-\sqrt{(r^2-x^2)}]-\frac{1}{3}\pi x^2\sqrt{(r^2-x^2)}$, hence that of the four segments $=\frac{8}{3}\pi r^2[r-\sqrt{(r^2-x^2)}]-\frac{4}{3}\pi x^2\sqrt{(r^2-x^2)}$. Hence, putting $r=1$ for convenience, we have the eq'n

$$4\pi x^2\sqrt{(1-x^2)}+\tfrac{8}{3}\pi-\tfrac{8}{3}\pi[\sqrt{(1-x^2)}]-\tfrac{4}{3}\pi x^2\sqrt{(1-x^2)}-\tfrac{16}{3}x^3=\tfrac{2}{3}\pi\,;$$

whence by reduction we find

$$8x^3+4\pi\sqrt{(1-x^2)^3}=3\pi.$$

Solving this equation by trial, I find $x=.474595$, or $x=.474595r$.

For a sphere 3 inches in diameter, $x=.711892$ inches.

If the holes are cut with a chisel, instead of an auger, what must be the width of the chisel?

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